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A new species of tooth-carp, *Aphanius mesopotamicus*, from Iran and Iraq (Actinopterygii, Cyprinodontidae)

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Abstract

A new species of tooth-carp, *Aphanius mesopotamicus* (Cyprinodontidae), is described from southern Mesopotamia in Iran and Iraq. It is distinguished from related species by pigmentation (males have clear margins to the unpaired fins, no bars on the caudal fin and 10–15 clearly defined flank bars; females bear irregular blotches or spots on the flank), distribution, and a suite of morphometric and meristic characters in multivariate space (pectoral fin rays, caudal peduncle length, scales to pelvic fin and postorbital length in males and pectoral fin rays, scales to dorsal fin, predorsal length and total scales in females). The description is based on museum specimens and there have been no recent collections of the new taxon.

Keywords

Aphanius, Cyprinodontidae, new species, Iran, Iraq

Introduction

The taxon *Aphanius sophiae* (Heckel 1849) has been widely used as the name of tooth-carps in various basins in southern Iran and Iraq, and even the Middle East generally. However, this species is restricted to the endorheic Kor River basin north of the city of Shiraz in Fars Province, Iran (Coad 1996). Studies over the past 20 years have demon-

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strated that a series of species exist in endorheic and exorheic basins of Iran as relicts of the Tethys Sea. They were initially recognized by their allopatric distributions and distinct pigment patterns and, later, in some cases by meristic characters, and in other cases principally by molecular characters (Coad 1988, 2000; Hrbek et al. 2006).

The purpose of this paper is to describe a new species from Iran and Iraq in the Persian Gulf drainage.

Material

The type material is housed in the collections of the Canadian Museum of Nature, Ottawa (CMNFI). Comparative material is in the Natural History Museum, London (BM(NH)) and the Zoological Institute, St. Petersburg (ZISP).

Methods

Measurements and counts follow Coad (1988, 1996). A set of 14 meristic counts summarised in Table 1 and of 22 standardized measurements (Table 2) were collected for all specimens.

Flank or cross-bar counts were taken by counting the number of dark bars (males only) on the mid-lateral series of scales on the left side.

Data ordination combining morphometric and meristic analyses follows Coad (1996). Principal components analysis (PCA) was done on a correlation matrix incorporating log-transformed, standardized size-free variates and untransformed meristic data using SYSTAT (SYSTAT, 2005). Discriminant function analysis (DFA) was used to identify characters that contributed most to group differentiation.

Results

Aphanius mesopotamicus Coad, sp. n.

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Type material. Holotype: female, 29.3 mm SL, Iran, Khuzestan, canal branch of Karkheh River, 31°40′N, 48°35′E, 27 January 1978, B. W. Coad and S. Coad (CMNFI 1979-0360A).

Paratypes: 37 (34 used in analyses, smallest male, smallest female and one deformed female not used in analyses), 14 males 17.1–23.9 mm SL and 23 females 14.6-29.1 mm SL, same locality as above (CMNFI 1979-0360B). 6(4 used in analyses, smallest of each sex not used in analyses), 3 males 17.1–19.9 mm SL and 3 females 15.1-20.5 mm SL, Iran, Khuzestan, Karkheh River branch at Abdolkhan, 31°52'30"N, 48°20'30"E, 27 January 1978, B. W. Coad and S. Coad (CMNFI 1979–0364). Other, non-type

Table 1. Meristic characters (n = 30 for *sophiae* males, 23 for *sophiae* females, 16 for *mesopotamicus* males, and 23 for *mesopotamicus* females). SD = standard deviation.

Character	Species	Sex	Range	Mean	SD
Dorsal fin rays	*sophiae*	♂	12–15	13.1	0.82
	mesopotamicus	♂	12–13	12.5	0.52
	sophiae	♀	11–15	13.0	0.82
	mesopotamicus	♀	11–13	12.4	0.58
Anal fin rays	*sophiae*	♂	10–13	11.8	0.82
	mesopotamicus	♂	10–12	11.1	0.62
	sophiae	♀	11–13	11.7	0.54
	mesopotamicus	♀	11–12	11.5	0.51
Pectoral fin rays	*sophiae*	♂	14–18	16.1	0.84
	mesopotamicus	♂	13–15	13.9	0.57
	sophiae	♀	15–19	16.3	0.93
	mesopotamicus	♀	14–15	14.1	0.29
Pelvic fin rays	*sophiae*	♂	5–6	5.9	0.35
	mesopotamicus	♂	5–6	5.7	0.48
	sophiae	♀	5–6	5.8	0.42
	mesopotamicus	♀	5–6	5.8	0.39
Lateral series scales	*sophiae*	♂	27–31	28.6	1.16
	mesopotamicus	♂	26–28	27.6	0.62
	sophiae	♀	25–31	28.8	1.23
	mesopotamicus	♀	26–29	27.3	0.82
Gill rakers	*sophiae*	♂	10–13	11.4	0.67
	mesopotamicus	♂	10–12	11.0	0.52
	sophiae	♀	10–12	11.5	0.59
	mesopotamicus	♀	11–14	11.4	0.71
Caudal peduncle scales	*sophiae*	♂	14–20	16.5	1.20
	mesopotamicus	♂	12–16	14.6	0.96
	sophiae	♀	15–19	16.6	1.16
	mesopotamicus	♀	12–16	14.1	1.04
Scales between lateral series and dorsal fin	*sophiae*	♂	4–6	5.3	0.58
	mesopotamicus	♂	4–5	4.3	0.45
	sophiae	♀	5–7	5.2	0.60
	mesopotamicus	♀	4–5	4.2	0.39
Scales between lateral series and anal fin	*sophiae*	♂	5–8	6.4	0.63
	mesopotamicus	♂	5–7	5.4	0.63
	sophiae	♀	5–7	6.2	0.60
	mesopotamicus	♀	4–6	5.2	0.60
Scales between lateral series and pelvic fin	*sophiae*	♂	6–8	7.4	0.67
	mesopotamicus	♂	5–7	6.3	0.58
	sophiae	♀	7–9	7.6	0.59
	mesopotamicus	♀	5–8	6.2	0.65
Total scales along flank	*sophiae*	♂	28–33	30.3	1.37
	mesopotamicus	♂	27–29	28.7	0.60
	sophiae	♀	27–32	30.5	1.31
	mesopotamicus	♀	27–30	28.3	0.81

Character	Species	Sex	Range	Mean	SD
Precaudal vertebrae	*sophiae*	♂	11–13	11.9	0.61
	mesopotamicus	♂	11–12	11.6	0.50
	sophiae	♀	11–13	11.9	0.46
	mesopotamicus	♀	11–13	11.8	0.49
Caudal vertebrae	*sophiae*	♂	15–17	16.2	0.55
	mesopotamicus	♂	15–17	16.0	0.63
	sophiae	♀	15–17	16.4	0.57
	mesopotamicus	♀	14–17	15.4	0.65
Flank bars (males)	*sophiae*	♂	10–21	14.3	2.63
	mesopotamicus	♂	10–15	12.4	1.36

material: 4, 2 males 22.7–24.3 mm SL, 2 females 20.2–25.3 mm SL, Iraq, Qarmat `Ali, Basrah, 30°34'N, 47°46'E, L. A. J. Al-Hassan (BM(NH) 1982.9.2:326-328).

Comparative material. *Aphanius sophiae*, material listed in Coad (1996, 1998).

Diagnosis. The new species is defined by pigmentation, distribution, meristics, and in multivariate morphometric and meristic space.

Males of the new species have clear margins to the unpaired fins, no bars on the caudal fin and have 10–15 clearly defined flank bars. Females bear irregular blotches or spots on the flank.

Pigmentation in *A. mento* and *A. dispar*, the two other and well-known species in the southern mesopotamian basin of Iraq and Iran, is highly distinctive. *A. mento* adult males are a dark blue-black with iridescent blue-white to silvery spots. *A. dispar* males have a caudal fin with 2–3 dark and light blue alternating broad bars, the last bar being yellow.

The new species has been confused with *A. sophiae* but this species is endemic to an endorheic basin of southern Iran. Females of *A sophiae*, however, have fine spotting on the flank. Twelve of 14 meristic characters are significantly different for males and 9 of 13 meristic characters for females, although ranges overlap in all cases (Table 5). Discriminant function analyses indicate that the variables with the best discriminating power are pectoral fin rays, scales to pelvic fin, postorbital length and caudal peduncle length in males and pectoral fin rays, scales to pelvic fin, scales to dorsal fin, total scales and predorsal length in females.

The new species is also distinguished from related species in western and southern Iran. Males of *A. isfahanensis*, a species endemic to an endorheic basin in west-central Iran, have very dark dorsal and anal fin margins. Females of *A. persicus*, a species endemic to an endorheic basin of southern Iran have thin, distinctive flank bars. Two other species, *A. ginaonis*, a hot spring endemic of southern Iran, and *A. vladykovi*, found in the high Zagros Mountains of Iran, are distinguished by non-overlapping meristic characters, respectively higher lateral scale counts (36–47; Coad 1988) and lower dorsal fin ray counts (5–7; Coad 1980).

Description. Meristic characters are summarised in Table 1 and morphometric characters in Table 2 in comparison with *A. sophiae*. Twelve of 14 meristic characters are significantly different ($p<0.05$) for males, although ranges overlap, the characters

Table 2. Morphometrics for *Aphanius sophiae* and *A. mesopotamicus*. SD = standard deviation.

			Number	Range	Mean	SD
Standard length/ Head length	*A. sophiae*	♂	30	3.2–3.6	3.5	0.11
		♀	23	3.2–4.0	3.6	0.18
	A. mesopotamicus	♂	16	3.2–3.6	3.4	0.12
		♀	23	3.3–3.7	3.5	0.09
Standard length/ Predorsal length	*A. sophiae*	♂	30	1.6–1.8	1.7	0.05
		♀	23	1.6–1.7	1.7	0.04
	A. mesopotamicus	♂	16	1.6–1.7	1.7	0.03
		♀	23	1.5–1.7	1.6	0.04
Standard length/ Prepelvic length	*A. sophiae*	♂	30	3.2–3.6	3.5	0.11
		♀	23	3.2–4.0	3.6	0.18
	A. mesopotamicus	♂	16	3.2–3.6	3.4	0.12
		♀	23	3.3–3.7	3.5	0.09
Standard length/ Preanal length	*A. sophiae*	♂	30	1.5–1.6	1.5	0.03
		♀	23	1.4–1.5	1.5	0.04
	A. mesopotamicus	♂	16	1.5–1.7	1.6	0.04
		♀	23	1.4–1.6	1.5	0.05
Standard length/ Body depth	*A. sophiae*	♂	30	2.7–3.9	3.2	0.24
		♀	23	3.0–3.9	3.4	0.23
	A. mesopotamicus	♂	16	3.1–3.7	3.4	0.19
		♀	23	3.2–3.7	3.5	0.13
Standard length/ Head depth	*A. sophiae*	♂	30	3.6–4.4	4.1	0.19
		♀	23	3.9–4.7	4.3	0.23
	A. mesopotamicus	♂	16	4.0–4.7	4.3	0.16
		♀	23	4.0–4.7	4.4	0.17
Head length/ Head width	*A. sophiae*	♂	23	1.3–1.7	1.5	0.09
		♀	30	1.4–1.7	1.5	0.07
	A. mesopotamicus	♂	16	1.5–1.7	1.6	0.06
		♀	23	1.3–1.6	1.5	0.07
Head length/ Head depth	*A. sophiae*	♂	30	1.1–1.2	1.2	0.05
		♀	23	1.1–1.3	1.2	0.06
	A. mesopotamicus	♂	16	1.1–1.3	1.3	0.05
		♀	23	1.1–1.3	1.2	0.04
Head length/ Orbit diameter	*A. sophiae*	♂	30	2.9–3.6	3.2	0.18
		♀	23	2.0–2.4	2.1	0.12
	A. mesopotamicus	♂	16	2.1–3.2	2.9	0.25
		♀	23	3.0–3.4	3.1	0.11
Head length/ Snout length	*A. sophiae*	♂	30	3.6–4.2	3.9	0.18
		♀	23	3.2–4.2	3.8	0.25
	A. mesopotamicus	♂	16	3.2–4.1	3.7	0.24
		♀	23	3.3–4.5	3.8	0.28
Head length/ Interorbital width	*A. sophiae*	♂	30	2.2–2.7	2.5	0.13
		♀	23	2.3–2.7	2.5	0.12
	A. mesopotamicus	♂	16	2.2–2.6	2.4	0.12
		♀	23	2.3–2.5	2.4	0.08

			Number	Range	Mean	SD
Head length/ Postorbital length	*A. sophiae*	♂	30	2.0–2.4	2.2	0.11
		♀	23	2.0–2.3	2.2	0.08
	A. mesopotamicus	♂	16	2.2–2.5	2.3	0.10
		♀	23	2.1–2.4	2.2	0.06
Head length/ Mouth width	*A. sophiae*	♂	30	2.8–3.6	3.1	0.19
		♀	23	2.8–3.5	3.2	0.20
	A. mesopotamicus	♂	16	2.7–3.5	3.0	0.20
		♀	23	2.6–3.3	3.0	0.18
Head length/ Dorsal fin length	*A. sophiae*	♂	30	0.9–1.2	1.0	0.09
		♀	23	1.0–1.4	1.2	0.11
	A. mesopotamicus	♂	16	0.8–1.2	1.0	0.09
		♀	23	1.2–1.4	1.2	0.07
Head length/ Anal fin length	*A. sophiae*	♂	30	1.1–1.5	1.3	0.09
		♀	23	1.3–1.6	1.4	0.08
	A. mesopotamicus	♂	16	1.1–1.3	1.2	0.09
		♀	23	1.3–1.5	1.4	0.06
Head length/ Pectoral fin length	*A. sophiae*	♂	30	1.4–1.8	1.6	0.09
		♀	23	1.4–2.0	1.7	0.15
	A. mesopotamicus	♂	16	1.5–1.8	1.6	0.10
		♀	23	1.5–1.9	1.7	0.09
Head length/ Pelvic fin length	*A. sophiae*	♂	30	2.5–3.5	2.9	0.24
		♀	23	2.7–3.7	3.2	0.33
	A. mesopotamicus	♂	16	2.9–4.3	3.4	0.33
		♀	23	2.8–3.8	3.4	0.25
Dorsal fin length/ Anal fin length	*A. sophiae*	♂	30	1.1–1.4	1.3	0.08
		♀	23	1.0–1.4	1.2	0.10
	A. mesopotamicus	♂	16	1.1–1.4	1.2	0.09
		♀	23	1.0–1.2	1.1	0.05
Pectoral–pelvic fin distance/ Pectoral fin length	*A. sophiae*	♂	30	1.1–1.5	1.3	0.09
		♀	23	1.1–2.0	1.5	0.22
	A. mesopotamicus	♂	16	1.0–1.3	1.1	0.07
		♀	23	1.2–1.7	1.4	0.12
Pelvic–anal fin distance/ Pelvic fin length	*A. sophiae*	♂	30	1.1–1.7	1.4	0.14
		♀	23	1.1–2.0	1.5	0.22
	A. mesopotamicus	♂	16	1.2–2.0	1.5	0.19
		♀	23	1.3–2.2	1.7	0.20
Caudal peduncle length/ Caudal peduncle depth	*A. sophiae*	♂	30	1.2–1.6	1.4	0.10
		♀	23	1.4–1.8	1.5	0.09
	A. mesopotamicus	♂	16	1.4–1.8	1.6	0.10
		♀	23	1.5–1.9	1.7	0.10

not significantly different being pelvic fin rays counts and precaudal vertebrae. Nine of 13 meristic characters are significantly different ($p<0.05$) for females, although ranges overlap, the characters not significantly different being anal and pelvic fin rays counts, gill rakers and precaudal vertebrae. Tests for normality and heteroscedasity show that 8 morphometric characters can be compared between species as ratios with t-tests in females but only one in males. Males are more similar morphometrically than females. The 8 significantly different ($p < 0.05$) characters in females are predorsal length, head depth and prepelvic length, all in standard length, and interorbital width, postorbital length, mouth width and anal fin length, all in head length, and head depth in head length. The sole male character is head width in head length.

Males are more distinct on the PCA (Fig. 2), where meristic and morphometric values are combined, than females (Fig. 3). The first 5 eigenvectors explain over 57% of total variance for males (Table 3) and also for females (Table 4). Discriminant function analyses for males show the variables with the best discriminating power are pectoral fin rays, caudal peduncle length, scales to pelvic fin and postorbital length and for females are pectoral fin rays, scales to dorsal fin, predorsal length and total scales (Table 5).

Description of pigmentation is based on preserved fish only (Fig. 1). Male pigmentation is as follows. The dorsal surface of the head and the upper flank are more heavily pigmented with melanophores than more ventral areas. The belly and lower

Figure 1. *Aphanius mesopotamicus*, holotype, female, 29.3 mm SL (CMNFI 1979-0360A) above; paratype, male, 21.7 mm SL (CMNFI 1979–0360B, below).

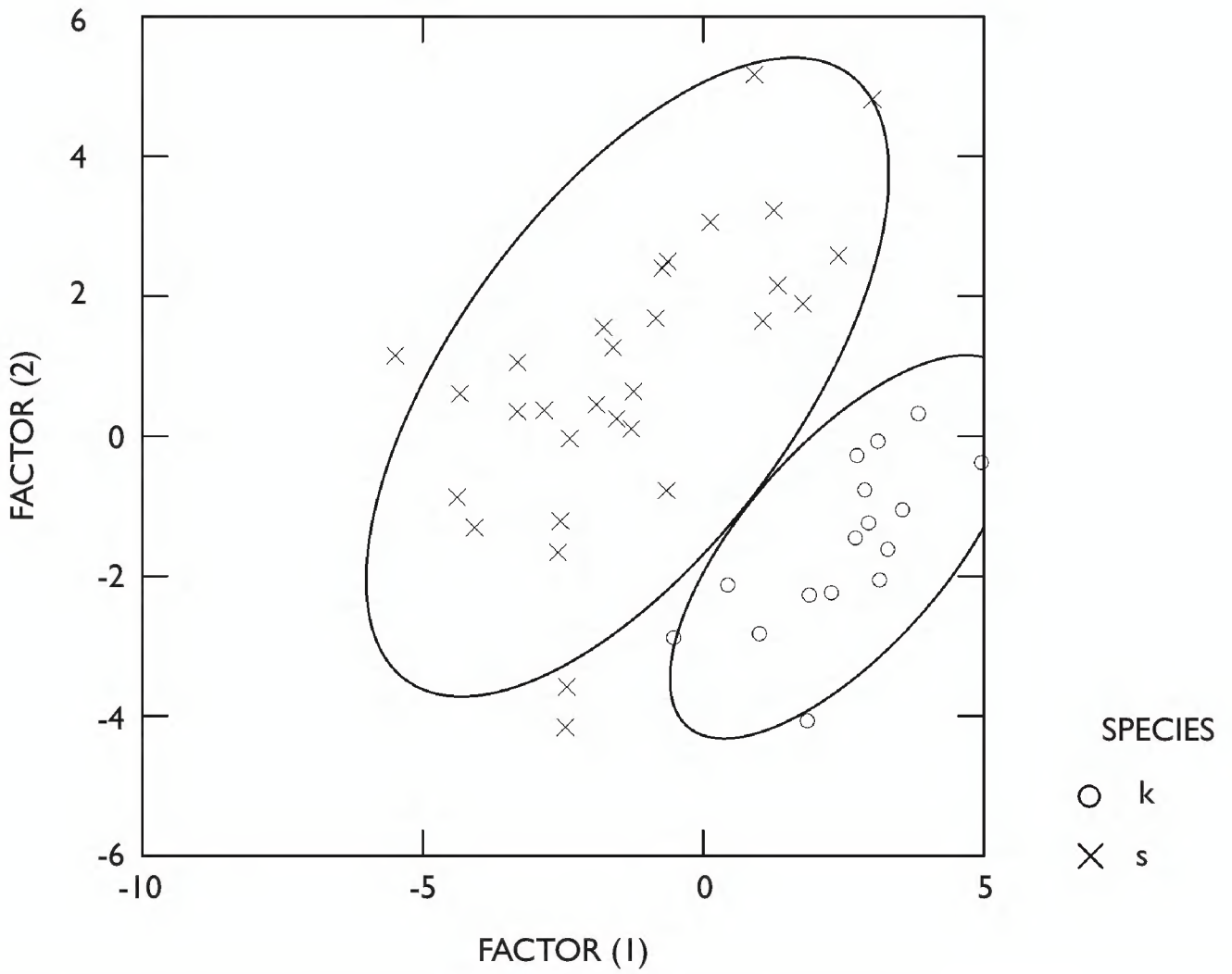

Figure 2. Principal components analysis for males of *A. mesopotamicus* **s** and *A. sophiae* **k**.

head are unpigmented. The chin and snout have dense melanophores and a rim of melanophores underscores the eye.

The dorsal, anal and caudal fins in males have wide clear margins. This is also seen in the material from Basrah, Iraq (BM(NH) 1982.9.2:326–328). The caudal fin in the type series of the new species is darker just proximal to the clear margin, lighter in mid-fin and dark again at the base. The dorsal fin has irregular pigmentation on the membranes and, to a lesser extent, on the rays. The pigmentation may involve an overall darker colour in contrast to the light margin or may have some pattern to it. The pattern is often elongate and short blotches with no regular arrangement and sometimes may appear as up to 5 wavy and oblique bands. Dark pigmentation is found just behind the first ray on the fin membrane. The anal fin is darkest just proximal to the clear margin. Up to the last 6 membranes of the anal fin are dark and this pigment may be broken up in as many as 4 elongate bars along each membrane. A similar pattern is found in some dorsal fins and the general effect on both fins is that the postero-dorsal (anal fin) and postero-ventral (dorsal fin) parts of these fins are the darkest. The dorsal, anal and caudal fins generally have more pigment on the membranes than the rays and in some this is quite distinctive, making the rays stand out.

The pectoral and pelvic fins in males are generally clear or somewhat milky and opaque and lack melanophores. The distal parts of the membranes between the last 5 rays of the pectoral fin and the small membrane area of the pelvic fins can be pigmented.

Table 3. Loadings of eigenvectors on thirty-three components produced by principal components analysis of 14 meristic counts and 22 standardized measurements for male/female *A. mesopotamicus* and *A. sophiae*.

Character/Component	1	2	3	4	5
Total scales	-0.790	-0.044	0.353	-0.019	0.020
Lateral series scales	-0.744	-0.202	0.309	0.142	0.001
Pectoral fin rays	-0.721	0.385	0.290	0.238	-0.084
Scales to dorsal fin	-0.687	0.308	0.342	0.121	-0.167
Dorsal fin height	0.678	0.047	0.493	-0.250	-0.092
Scales to anal fin	-0.669	0.032	0.242	-0.150	-0.017
Anal fin height	0.663	-0.075	0.227	-0.236	-0.181
Scales to pelvic fin	-0.600	0.290	0.439	0.008	0.261
Body depth	0.594	0.569	0.180	-0.196	0.063
Interorbital width	0.553	-0.053	0.350	-0.275	0.012
Snout length	0.533	0.127	0.308	0.430	0.010
Prepelvic length	-0.075	0.811	-0.296	-0.038	-0.033
Pectoral to pelvic fin distance	-0.158	0.674	-0.398	-0.252	0.080
Preanal length	-0.185	0.621	-0.263	0.019	0.312
Head depth	0.251	0.616	0.110	0.042	0.191
Postorbital length	0.285	0.614	0.031	0.127	-0.275
Pelvic fin length	0.182	0.535	0.129	0.283	0.280
Caudal peduncle depth	0.231	0.524	0.134	0.088	-0.298
Orbit diameter	0.384	-0.098	0.532	0.455	-0.138
Caudal vertebrae	-0.317	0.059	-0.337	0.576	0.012
Caudal peduncle length	0.140	-0.487	0.270	0.517	0.095
Pelvic to anal fin distance	0.054	-0.211	0.249	0.012	0.690
Anal fin rays	-0.437	0.276	-0.255	-0.059	-0.546
Pelvic fin rays	-0.288	0.048	0.411	-0.013	0.118
Predorsal length	0.291	0.295	0.041	-0.375	0.292
Head width	0.107	0.382	-0.109	0.289	0.213
Precaudal vertebrae	-0.235	-0.047	0.479	-0.499	-0.175
Dorsal fin rays	-0.489	0.245	0.089	-0.047	-0.363
Caudal peduncle scales	-0.488	0.257	0.499	0.021	0.029
Gill rakers	-0.283	0.228	0.418	-0.303	0.170
Head length	0.453	0.461	0.174	0.352	-0.060
Mouth width	0.477	-0.064	-0.304	0.121	-0.401
Pectoral fin length	0.461	0.303	0.312	0.016	-0.021
Percent variance explained	21.250	14.031	9.816	6.726	5.564

Males have flank bars circling the caudal peduncle and reaching the anal fin base but fading ventrally on the lower part of the anterior flank, not reaching the ventral margin of the belly and becoming progressively shorter and less distinct the more anterior they are. Bars are 2–5 times broader than the pale interspaces.

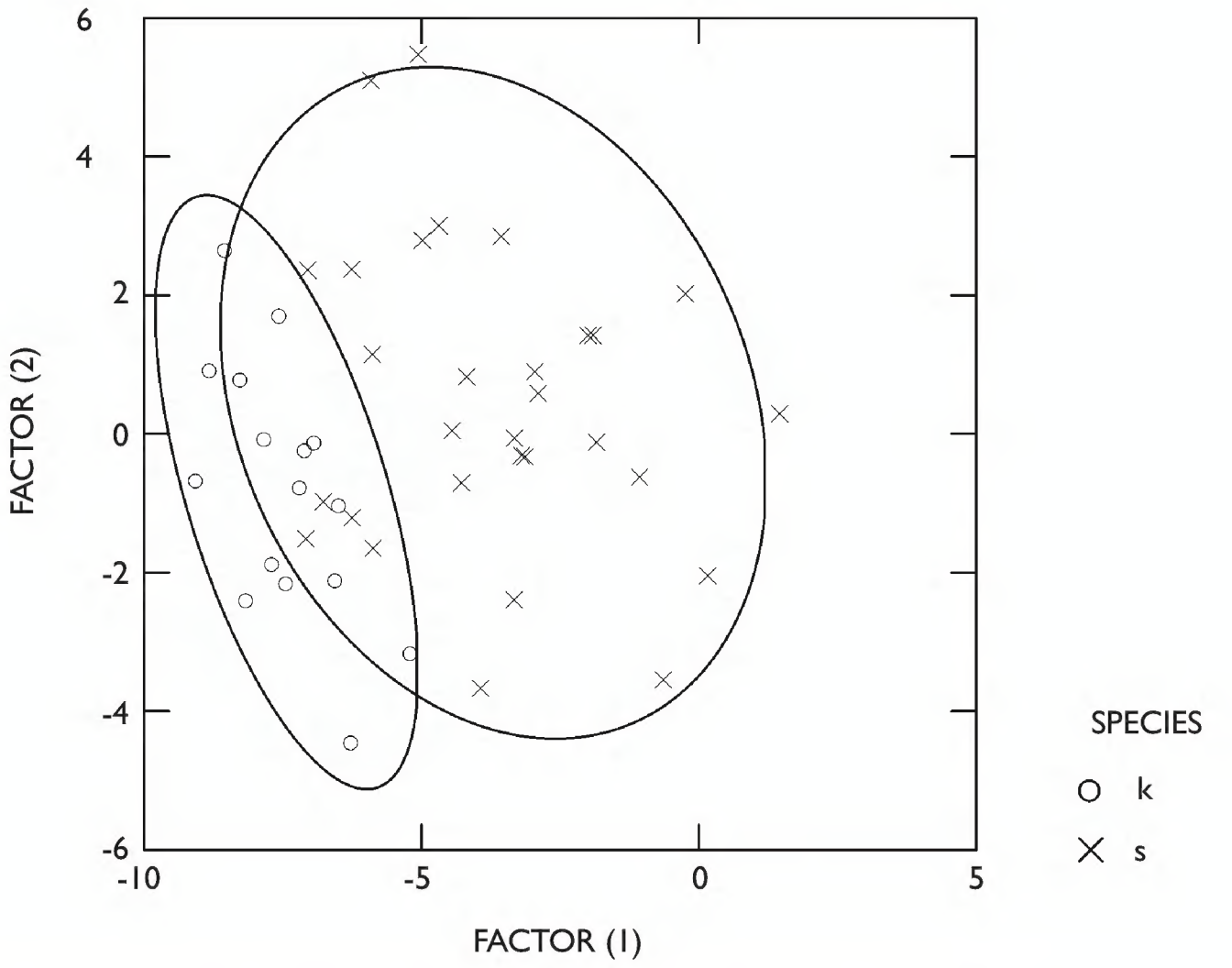

Figure 3. Principal components analysis for females of *A. mesopotamicus* **s** and *A. sophiae* **k**.

Females have a similar head and dorsal and ventral body pigmentation but it is much lighter than in males. Fins have little or no pigmentation. The proximal third to half of the dorsal fin rays and membranes, particularly the anterior ones, have pigment in some fish but this is weakly expressed compared to the condition in males. Some fish have a few faint melanophores lining the anal fin rays.

The most distinctive feature in these females is a spot, oval to lozenge-shaped, at the central base of the caudal fin. The spot has the greatest concentration of melanophores of any pigmentation feature.

The flank in females can have up to 14 thin, dark, wavy and irregular vertical patches of pigment. These patches may be interrupted in their vertical extent and are weakly expressed anteriorly. They fade ventrally, ending above the lower edge of the caudal peduncle and above the anal fin base, and are absent on the lower anterior flank. The patches are light and not as contrasting with the lighter interspaces as the bars found in males. Patches are thin, half to one third of the width of the interspaces. Very often the patches are broken up into spots and elongate blotches of various sizes, and a regular barred appearance is not usual. The spots and blotches are all smaller than the eye size by at least half. Material from Basrah, Iraq figured by Berg (1949; Fig. 5 herein) has the spots emphasised but material from Basrah (BM(NH) 1982.9.2:326–328) examined for this study has a more blotchy appearance and spots are not well-defined.

Table 4. Loadings of eigenvectors on thirty-three components produced by principal components analysis of 14 meristic counts and 22 standardized measurements for male/female *A. mesopotamicus* and *A. sophiae*.

Character/Component	1	2	3	4	5
Pectoral fin rays	0.775	0.261	0.068	0.208	0.021
Total scales	0.756	0.188	0.084	0.082	0.230
Anal fin height	-0.686	0.282	0.201	0.234	-0.002
Interorbital width	-0.682	0.358	0.015	0.042	0.134
Scales to anal fin	0.673	0.309	0.137	0.038	-0.108
Scales to dorsal fin	0.668	0.416	0.163	0.195	0.008
Scales to pelvic fin	0.657	0.397	0.163	-0.056	-0.243
Lateral series scales	0.649	0.203	0.004	0.228	0.272
Dorsal fin rays	0.625	-0.180	0.242	0.030	0.115
Caudal peduncle scales	0.603	0.485	0.056	-0.007	-0.124
Head depth	-0.106	0.790	0.070	-0.124	0.024
Postorbital length	-0.380	0.604	0.159	0.404	-0.286
Head length	-0.447	0.604	0.142	0.342	-0.098
Body depth	-0.132	0.555	-0.089	-0.587	0.113
Prepelvic length	0.108	0.535	-0.647	0.296	-0.187
Caudal peduncle depth	0.305	0.523	0.255	-0.253	-0.094
Preanal length	-0.020	0.386	-0.655	0.056	-0.361
Caudal peduncle length	0.014	-0.352	0.644	-0.012	0.044
Pectoral fin length	-0.013	0.051	0.629	-0.215	-0.470
Orbit diameter	-0.379	0.236	0.512	0.075	0.228
Caudal vertebrae	0.245	-0.206	-0.004	0.642	0.040
Precaudal vertebrae	0.285	0.230	-0.047	-0.533	0.347
Pelvic fin length	-0.103	0.096	0.436	0.044	-0.557
Anal fin rays	0.489	-0.264	0.250	0.114	0.033
Gill rakers	0.316	0.412	0.068	-0.238	0.120
Pelvic to anal fin distance	-0.238	-0.209	0.267	-0.262	-0.158
Dorsal fin height	-0.455	0.175	0.172	-0.272	-0.420
Mouth width	-0.467	0.301	0.250	0.389	0.405
Predorsal length	-0.449	0.232	-0.373	-0.135	0.278
Pelvic fin rays	0.204	0.469	0.220	-0.025	0.252
Pectoral to pelvic fin distance	0.389	-0.013	-0.492	-0.168	-0.353
Snout length	-0.383	0.345	-0.007	0.211	0.073
Head width	-0.268	0.422	0.080	-0.288	0.304
Percent variance explained	20.673	14.177	9.356	6.923	5.986

Etymology. The species is named for Mesopotamia (the land between the rivers) referring to the Tigris-Euphrates basin where the species is found. A proposed common name is Mesopotamian tooth-carp.

Distribution. *Aphanius mesopotamicus* is recorded from the southern Karkheh River basin of Iran and at Qarmat `Ali in Iraq at the northern part of Basrah on the

Table 5. Seven variables selected in backward estimation discriminant function analysis of 14 meristic counts and 22 standardized measurements by sex. The magnitude of the F-to-remove statistic indicates the relative ability of the classification power of the variable.

Variable	F-to-remove	Tolerance
Females		
Pectoral fin rays	30.99	0.8241
Scales between lateral line and dorsal fin	8.05	0.7438
Predorsal length	6.06	0.8112
Total lateral series scales	5.10	0.9581
Scales between lateral line and elvic fin	4.76	0.7305
Length longest dorsal fin ray	3.88	0.5936
Dorsal fin rays	3.68	0.6429
Males		
Pectoral fin rays	52.79	0.7133
Caudal peduncle length	7.96	0.4928
Scales between lateral line and elvic fin	6.71	0.8884
Postorbital length	5.85	0.6339
Pectoral to pelvic fin origin istance	5.01	0.6891
Head depth	4.53	0.6924
Preanal length	2.86	0.4726

Shatt al Arab, the confluence of the Tigris and Euphrates rivers (Fig. 4). The Karkheh River drains to the Hawr-al-Azim marshes of the Tigris River basin on the Iran-Iraq border.

Material called *A. sophiae* by Berg (1949) from Basrah, Iraq (Zoological Institute, St. Petersburg, ZISP 25393, male and female figured) and possibly material from Shellali (presumably Shalili-ye Bala or Shalili-ye Pa'in, ca. 31°58′N, 48°53′E) near Shushtar, Karun River basin, Iran (ZISP 25446) are presumably the new species described herein.

Conservation. The new species is known from only about 4 localities in southern Mesopotamia and has not been collected since 1978 in Iran and the early 1980s in Iraq. Specimens from Iran were easily caught using a dip-net. Several recent attempts post-2000 by the author and colleagues in both countries have failed to capture more specimens. It is not possible to assess whether this was due to chance or loss of the populations.

Habitat. The habitat of the new species is known only from field notes made at the time of capture in Iran on the Khuzestan plains. The two localities are a river and a canal branching from that river. The 25 m wide river had a water temperature of 22 °C at 1205 hours, pH 6.0, conductivity 1.0 milliSiemens, a mud bottom and the principal plant materials were rushes and reeds. The 30 m wide canal had a water temperature of 15 °C at 0930 hours, pH 6.0, conductivity 1.8 milliSiemens, a mud bottom and the principal plant material was filamentous green algae.

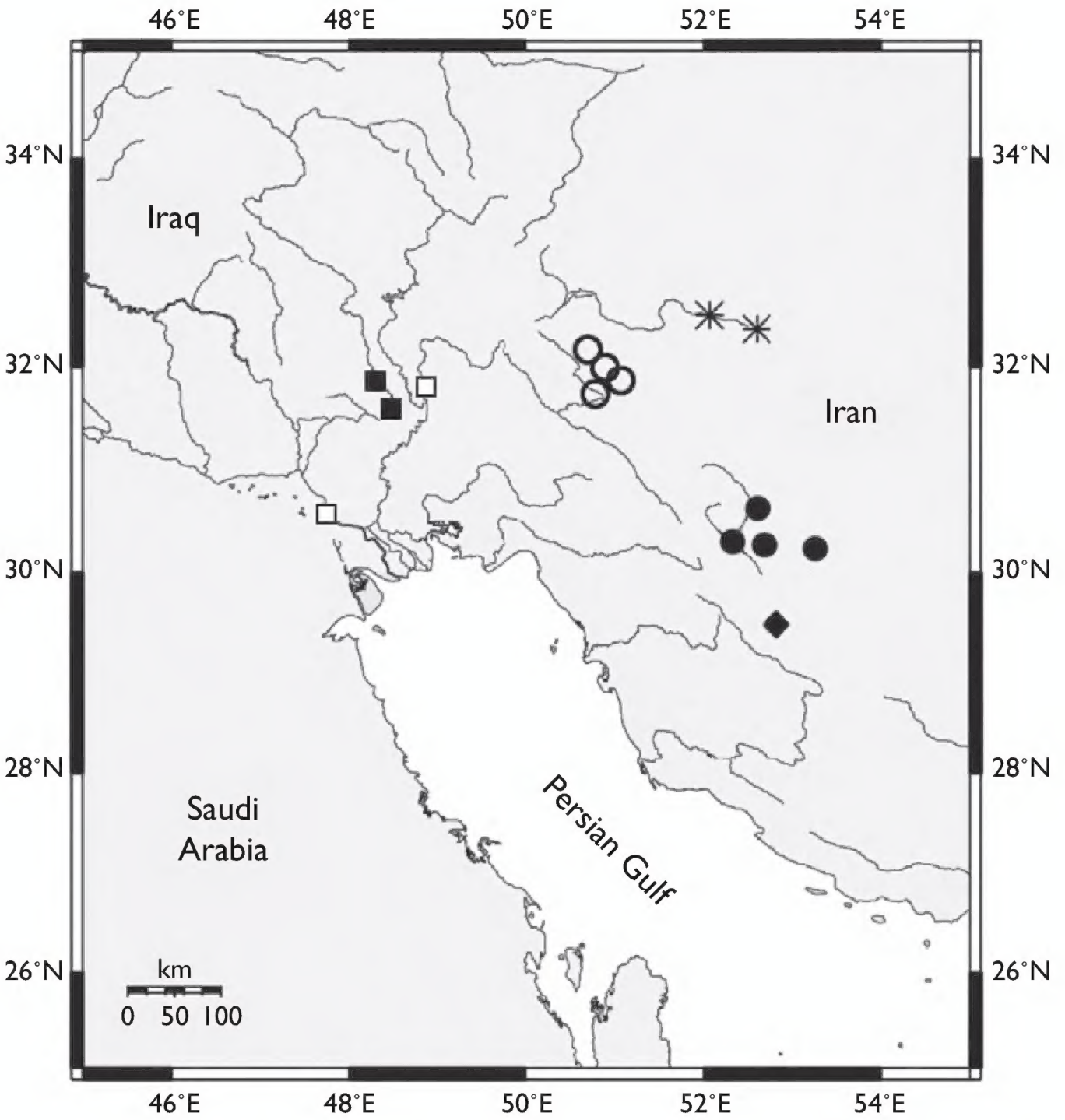

Figure 4. Distribution map of *Aphanius* in Mesopotamia and adjacent areas. Solid squares type series of *A. mesopotamicus* (lower one CMNFI 1979-0360A and B, upper 1979-0364), open squares additional, non-type material of *A. mesopotamicus* [BM(NH) 1982.9.2:326–328 and ZISP 25393 (lower left) and ZISP 25446 (adjacent to type series)], open circles *A. vladykovi*, stars *A. isfahanensis*, solid circles *A. sophiae*, and diamond *A. persicus* [map modified after Hrbek et al. (2006)].

Discussion. *Aphanius* species in Iran and Iraq show sexual dimorphism in pigmentation that can be used to identify and separate species. Generally, morphometric and meristic characters overlap and are only useful in multivariate space. Molecular techniques and otolith morphometry add confirmatory evidence to colour patterns (Hrbek et al. 2006; Reichenbacher et al. 2007) but are not available for older material. Attempts to capture fresh material for molecular or otolith analyses of the new species by colleagues in Iran and Iraq have so far proved nugatory. Hrbek et al. (2006) give comparative tables for meristic and morphometric characters in species found in drainages adjacent to the new species (see Fig. 4).

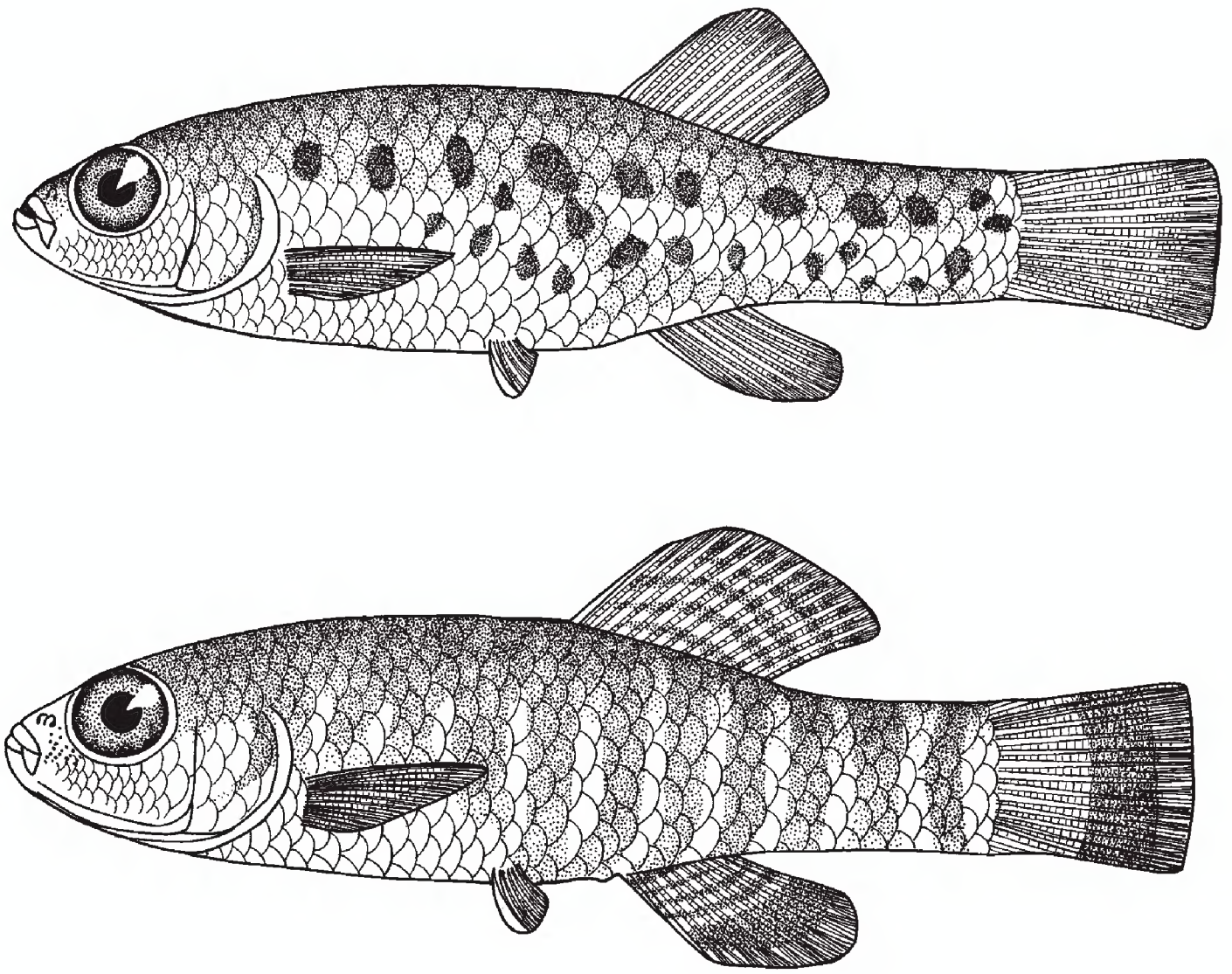

Figure 5. *Aphanius* from Basrah, Iraq (ZISP 25393) after Berg (1949). Female (above), 30 mm, and male, 29 mm.

Fish with wide, clear margins to the dorsal, anal and caudal fins in males is seen in material from Basrah figured by Berg (1949; Fig. 5 herein) although only in some printed versions of the figures (available only in photocopies) and this is not as evident in the figures here taken from the original drawings in St. Petersburg.

Coad (1996) reviews the nomenclatural history of nominal *Aphanius* species in southern Iran.

While these small fishes thrive in habitats marginal for other species, such as very small springs around salt lakes and saline habitats, they are less common in larger water bodies, at least in Iran. Introductions of exotics, particularly the mosquitofish *Gambusia holbrooki*, have placed the tooth-carps at a competitive disadvantage. Large-scale aquaculture projects involving cyprinids and the malaria eradication programme involving mosquitofish have accidentally introduced many species outside their normal distribution in Iran. This may confound natural distribution patterns as smaller species are transported unawares along with the desired species. Historical collections are therefore important in describing and assessing the biodiversity of the Iranian ichthyofauna and even relatively recent collections may add to the known fauna as an understanding of diversity develops.

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